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REPORT OF WATER QUALITY IN GOLDEN LAKE

1972



Ontario

Ministry
of the
Environment

The Honourable
William G. Newman,
Minister

Everett Biggs,
Deputy Minister

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REPORT
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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

The heavy influx of people may subject the lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970, in order to solve the cottage waste disposal program in recreational lakes. There are three on-going studies carried out by the Ministry:

- 1) evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.

- 2) research to improve the knowledge of septic tank operation and effects of shallow soil areas and evaluation of alternative methods of private waste disposal.
- 3) evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Golden Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Golden Lake in 1972 in June, August and October, to evaluate the present status of the water quality with respect to bacteria, algae and aquatic plant growth. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were determined.

Golden Lake is located in the County of Renfrew and lies within the Canadian Shield. The area is characterized by rolling hills, and shallow overburden covering crystalline bedrock. The west end of the lake is flat and poorly drained. The remaining shoreline is gradual to steeply sloping with frequent rocky outcrops.

The bacteriological water quality of Golden Lake was quite good with the exception of the inflow of Brudenell Creek, which was a definite public health hazard. A recent water quality study of the Brudenell Creek has indicated the Village of Killaloe Station as the source of this contamination. However, it is expected that this situation will be corrected with the installation of the village sewage works, which is presently in the final design stage.

Similarly, the substantial nutrient input detected in Brudenell Creek should diminish with the completion of the Killaloe sewage works. The chemical water quality was good with low concentrations of nutrients and small amounts of suspended algae throughout the lake. However, a relatively high percentage of the total shoreline length was populated by heavy growths of aquatic plants. The decomposition of these growths may contribute to the low dissolved oxygen concentrations in the bottom waters in October which were unsuitable for sensitive fish.

Cottagers should ensure that their waste disposal systems are functioning properly to prevent nutrients and bacteria from gaining access to the lake. The incidence of swimmer's itch in Golden Lake is a most significant water quality problem. Studies carried out over the past few years by staff of the Ministry of the Environment on Golden Lake have indicated that control methods presently available are not very effective however and chemical methods of control are not recommended.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- density and species of aquatic plants
- inventory of shoreline development

In addition, some results of work carried out in previous years to define the extent of the "Swimmer's Itch" problem in Golden Lake are presented in this report.

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions, since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae.

Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

The growth of weeds along the shore was noted during the surveys. Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 20 to 24, August 15 to 19 and October 3 to 7.

A proper estimation of the bacterial population requires several measurements over a period of time, which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and on the first, third and fifth days at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Forty-two bacteriological sample sites were established over the whole lake. Chemical samples were collected at 2 inlet stations, 1 outlet station and at 4 mid-lake stations. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid-lake stations. Aquatic plants samples were collected in areas representative of sparse, medium and dense growth.

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the incidence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denotes the presence of fecal contamination and probably disease causing organisms.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques, depend on the mineral content.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly

important in bottom waters since nitrogen is regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of suspended algae in the water. The live algae are confined mainly to the illuminated surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottom through the depth of the illuminated surface water as it filled. The sample was then representative of the algal density through the sampling depth.

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

Secchi Disc Reading

2 times Secchi disc reading

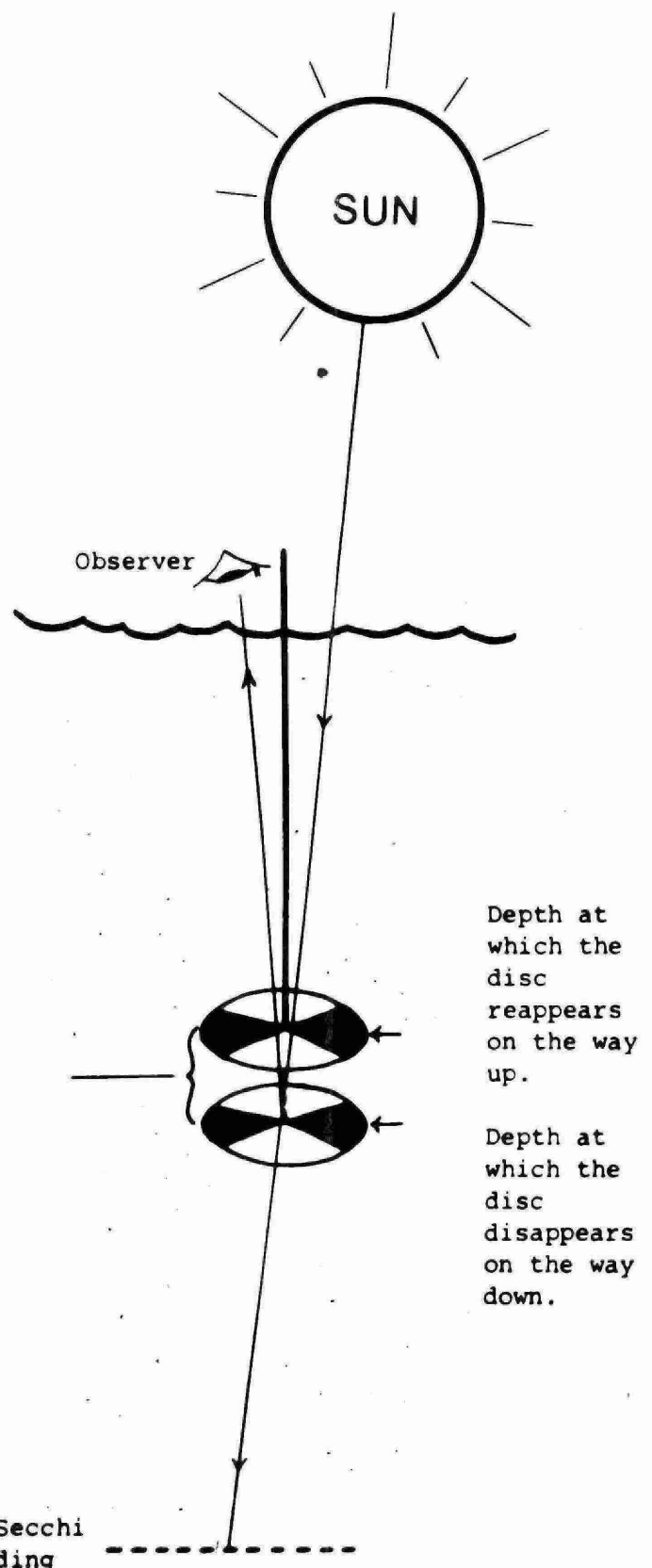


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY.

AREA DESCRIPTION

Lake and Soil Characteristics

Golden Lake is located in North Algona Township, County of Renfrew and is approximately 13 kilometers (8 miles) west of Eganville (Figure 2).

The lake lies in the Canadian Shield and the area is characterized by rolling hills covered with shallow well-drained overburden showing frequent outcroppings of crystalline bedrock. The soils along the shoreline are composed of gravelly sandy loam, with several areas of localized Muck (Figure 3). A section of the west shore is low-lying and exhibits poor drainage characteristics. The area is covered with medium to heavy growths of mixed forest with active farmland scattered throughout the area.

The Golden Lake drainage area, consisting of 346 square kilometers (134 square miles), lies in the Bonnechere River watershed, which is part of the Ottawa River Terminal Drainage Basin. The general flow of water is from west to east. In addition to the flow of the Bonnechere River the lake also drains Quable Lake, Rattrays Lake, Mud Lake, Silver Lake and Brudenell Lake. Bonnechere River is the only outlet. The lake has a maximum length of 11 kilometers (7.0 miles) and width of 6 kilometers (3.8 miles). It has approximately 34 square kilometers (13 square miles) of surface area and 47 kilometers (29 miles) of irregular shoreline (Figure 2). Its mean depth is 9 meters (29 feet) and its maximum depth is 24 meters (80 feet). The total volume of Golden Lake is 299,950,000 cubic meters (243,000 acre feet).

FIGURE 2 - COTTAGE DEVELOPMENT AND CONTOURS OF GOLDEN LAKE

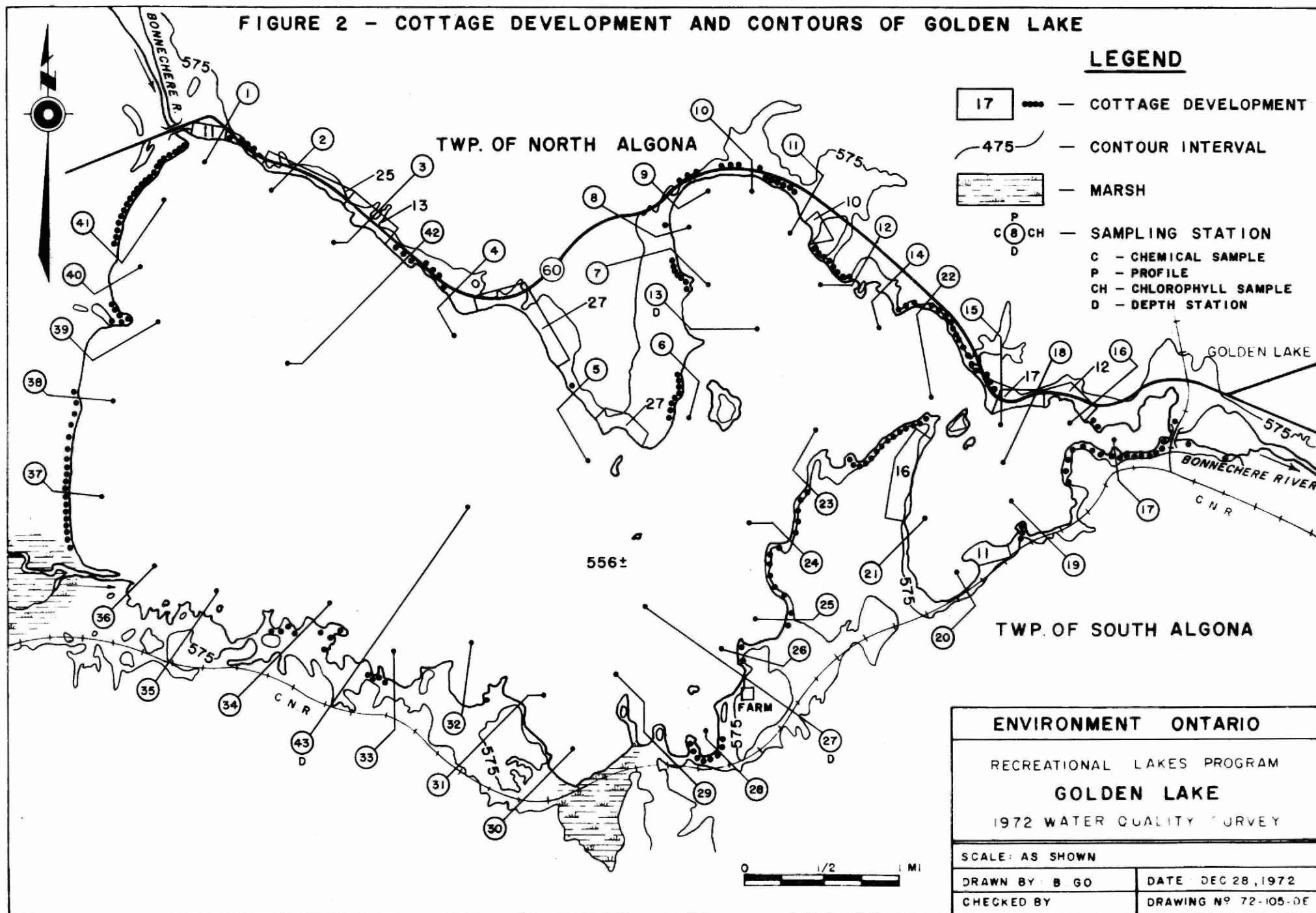
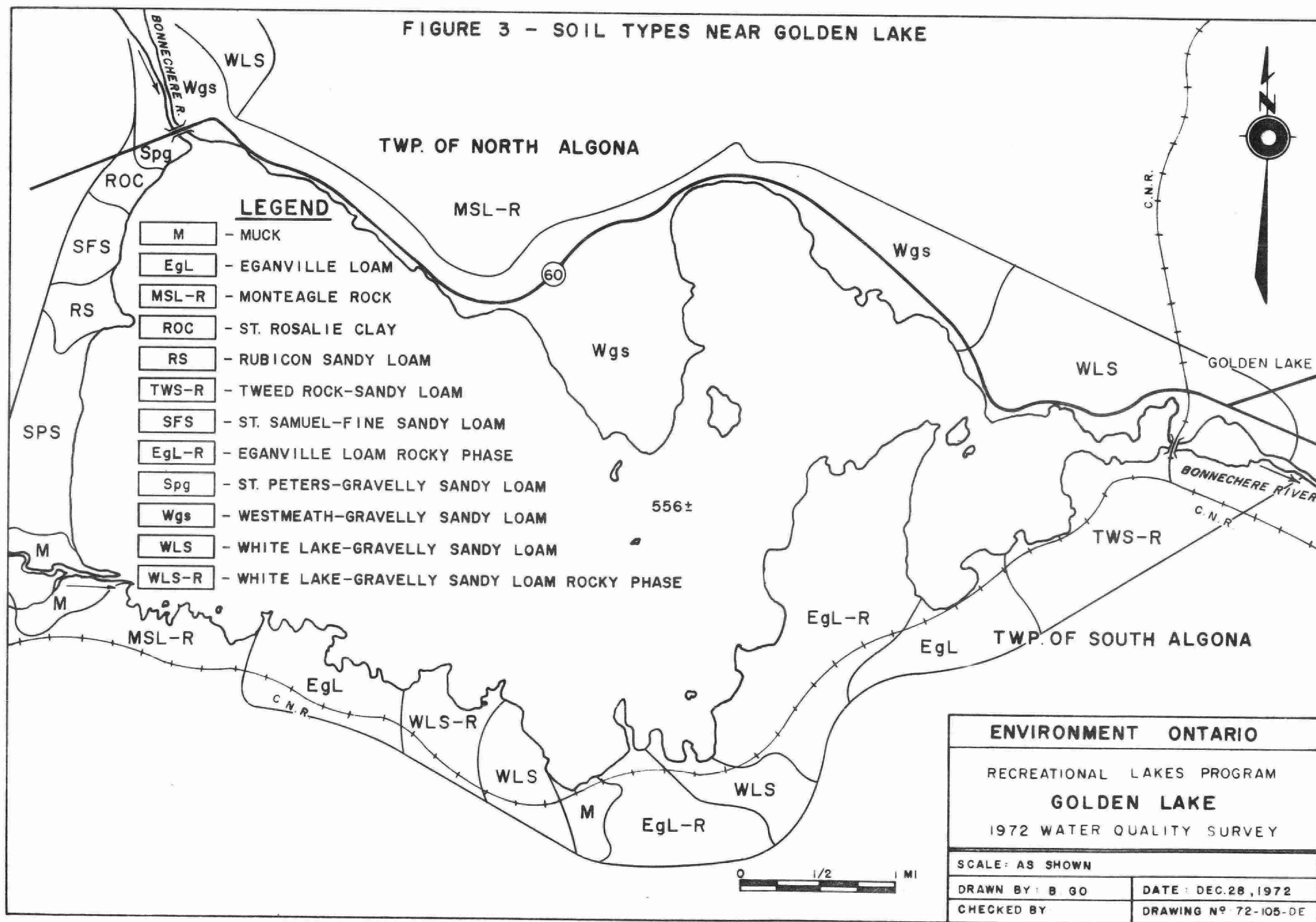


FIGURE 3 - SOIL TYPES NEAR GOLDEN LAKE



Water Usage

Most cottagers use the lake as their source of domestic water supply. Recreational use of the lake include boating, swimming, and angling. The common game fish are largemouth and smallmouth bass, lake whitefish, yellow perch, pickerel and northern pike.

There are no known direct discharges of wastes into Golden Lake from Communal or municipal sewage treatment facilities. However, a study undertaken by the Sanitary Engineering Branch in 1972 revealed the Village of Killaloe Station as a source of contamination to the Brudenell Creek. It is expected that this situation will be corrected with the installation of the Village waste stabilization lagoon which is presently in final design. The treated effluent will be discharged to the Brudenell Creek.

Shoreline Development

Road access has probably determined the development pattern of the 349 cottages on Golden Lake. Highway No. 60 follows the west and north shores which contain 72 percent of the cottages and the hamlets of Decon and Golden Lake. The remaining cottages on the south shore of the lake are accessible by a county road.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The data received from the 1972 spring, summer, and fall surveys indicate that Golden Lake, with the exception of the south-west inlet (Brudenell Creek) was within the Ministry of the Environment (MOE 1972) Criteria which states: "Where ingestion is probable, recreational waters can be considered impaired when the total coliform (TC), fecal coliform (FC), and/or enterococcus (FS) geometric density exceeds 1000, 100 and/or 20 per 100 ml respectively,". (1)

In June, most stations (Group A) revealed a TC geometric mean level of 72 TC / 100ml. The inlet stations (Stations 1, 11, 36) had TC means of 369, 931, and 2855 / 100ml while a moderately cottaged south-east bay showed a mean of 85 TC / 100ml (Figure 4).

All stations except Station 36 were homogeneous for FS during this survey with a mean of 11 FS/100ml. FC means over most of the lake (Group A) were 1 FC/100ml but the south-west portion of the lake within the influence of Brudenell Creek (Station 36) exhibited a substantially higher mean of 115 FC/100ml. Because of the extremely high concentrations of 2855 TC, 115 FC and 289 FS/100ml at the inlet of Brudenell Creek (Station 36), this area poses a potentially dangerous public health hazard. A recent MOE survey has indicated the Village of Killaloe Station as the source of this contamination.

In August, mean bacterial concentrations for most stations (Group A) were 140 TC, 1 FC and 2 FS/100ml. At no time did the bacterial densities for all parameters exceed the MOE Criteria at any station (Figure 5).

In October, TC, FC AND FS densities were 157, 1 and 2/100ml for the majority of stations (Group A). All stations were within the MOE Criteria and although several isolated stations had higher means than Group A, none exhibited unacceptable counts (Figure 6). Again, Station 36, in the mouth of the Brudenell Creek had higher bacterial levels of 313 TC and 11 FC/100ml.

The Killaloe Climatological station recorded a total of 3.82 inches of rain during the five day June survey, with a high of 2.26 inches on June 22. Counts at most stations along the shoreline, especially those in the vicinity of the inlets (Stations 1,9,10,11,36) increased considerably the following day for all parameters (Figure 7).

FIGURE 4 - DISTRIBUTION OF BACTERIA IN JUNE

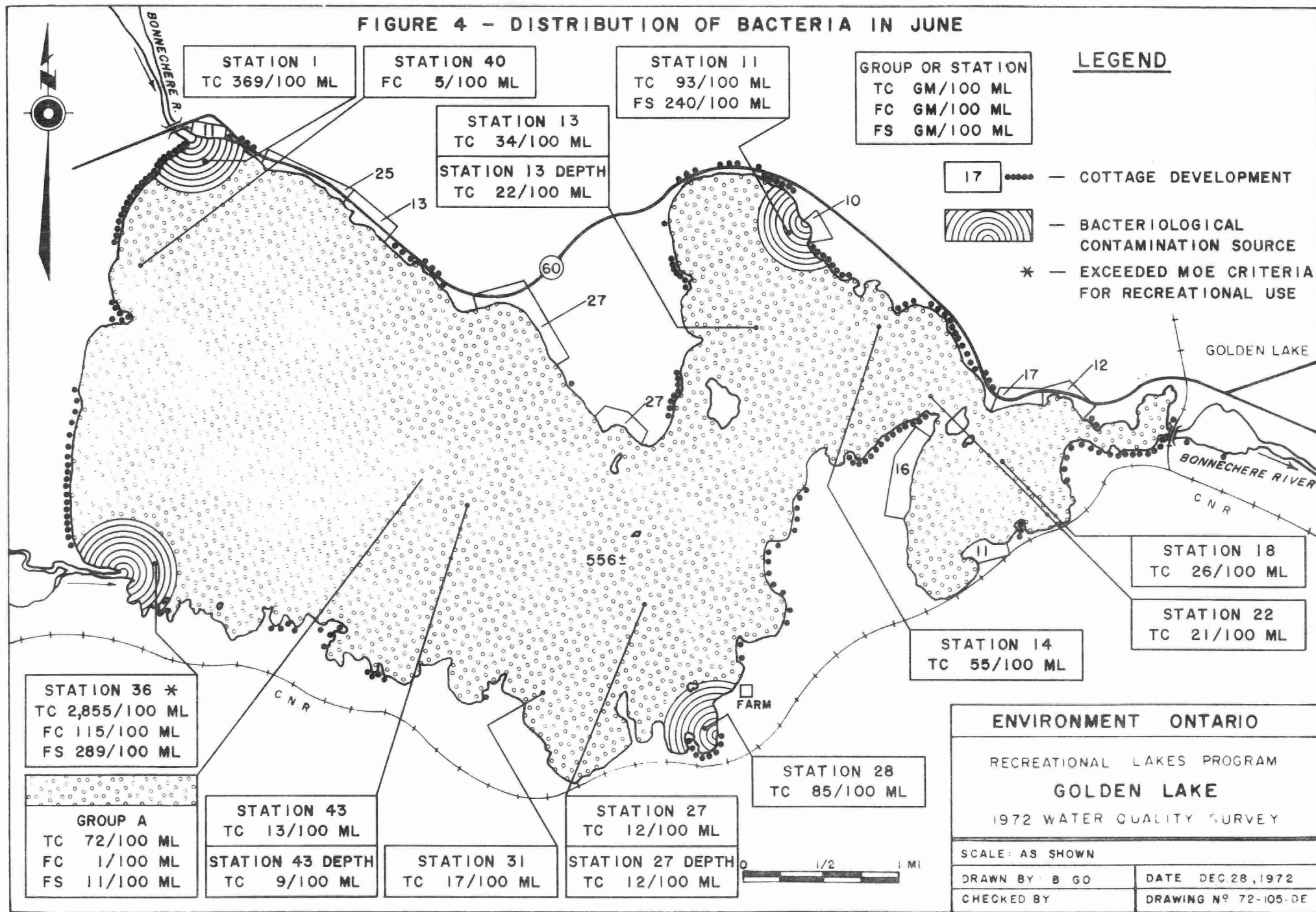


FIGURE 5 - DISTRIBUTION OF BACTERIA IN AUGUST

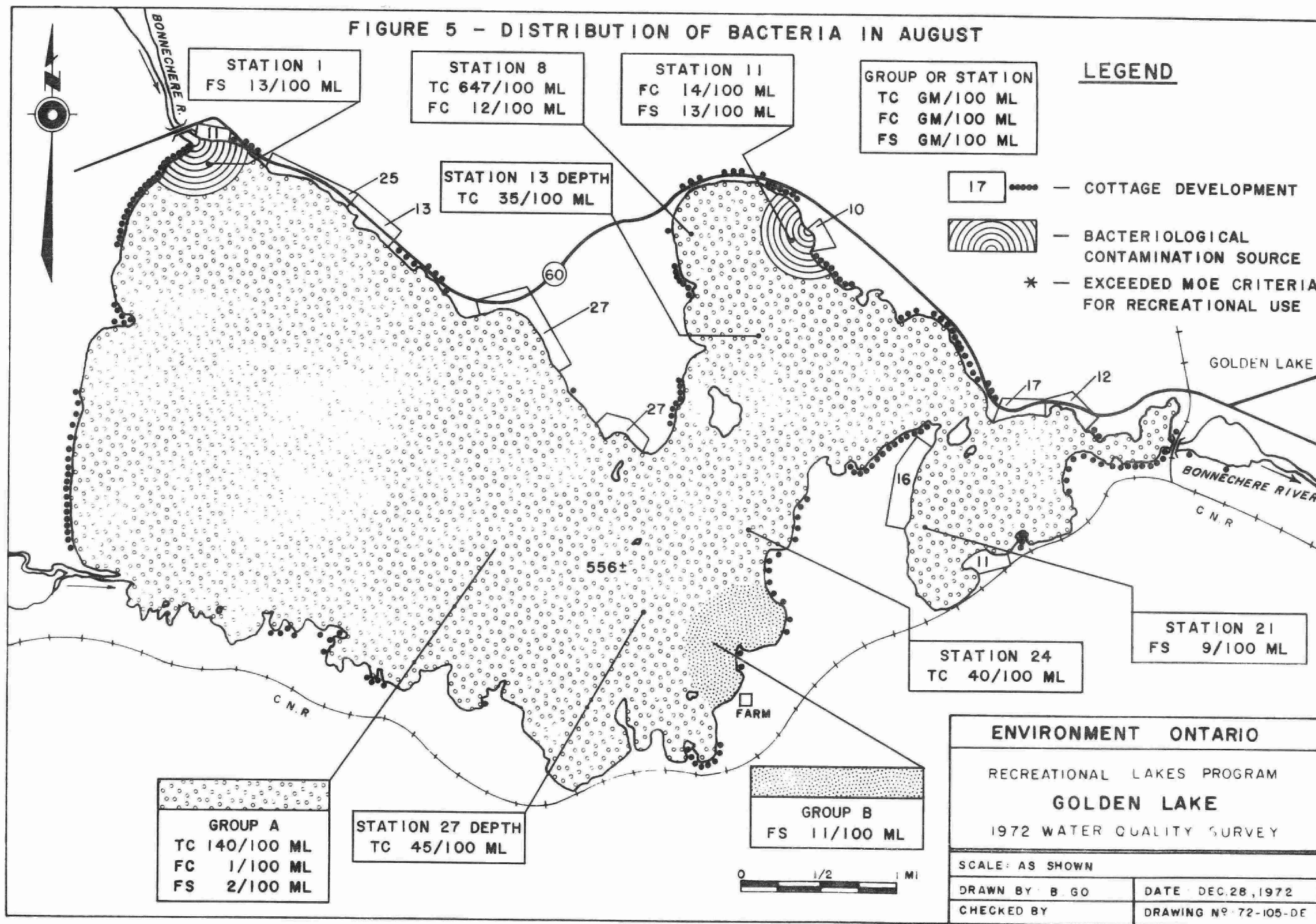
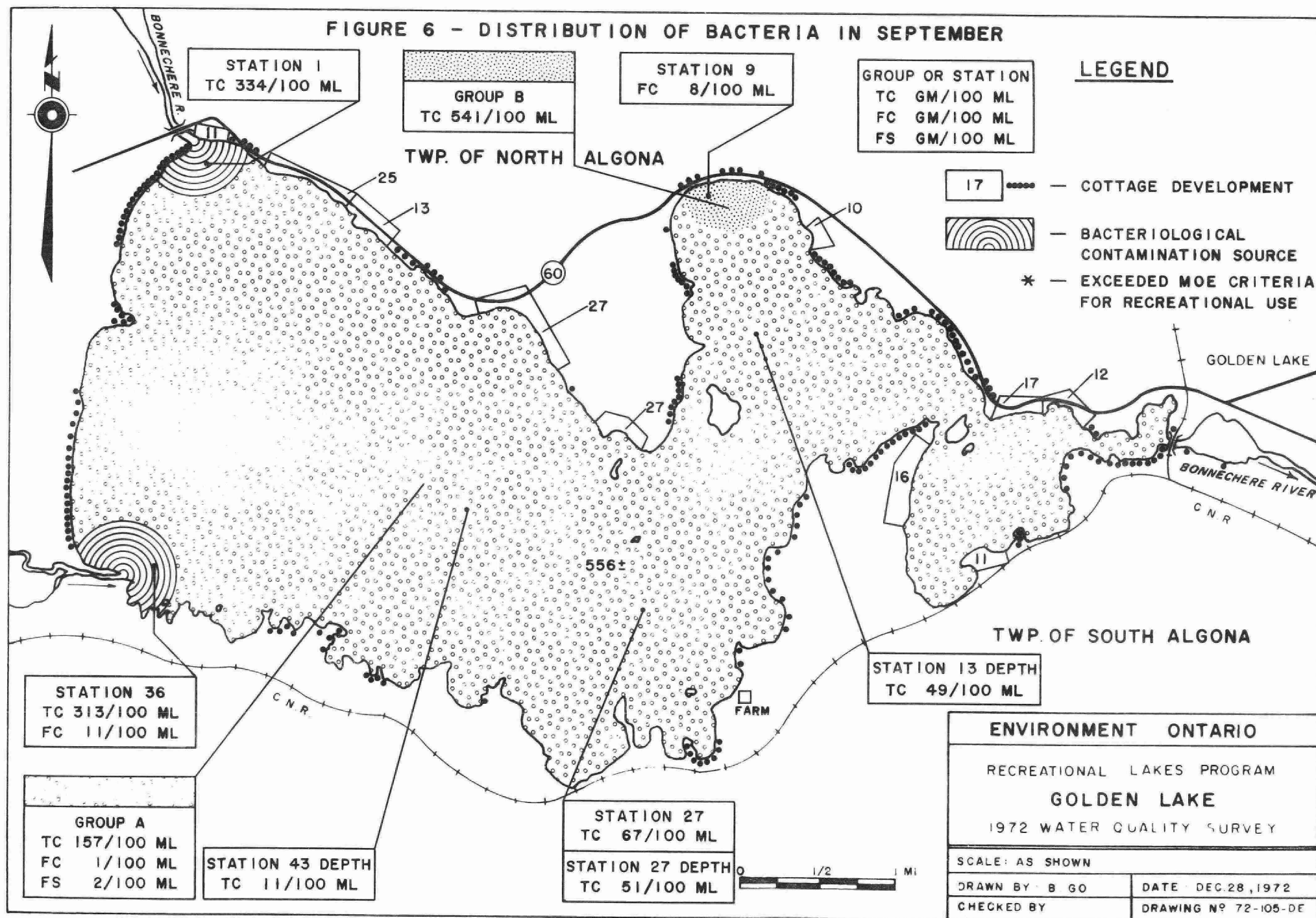


FIGURE 6 - DISTRIBUTION OF BACTERIA IN SEPTEMBER



Generally Golden Lake displayed progressively higher TC counts throughout the surveys, although FC and FS levels remained relatively constant.

- (1) Guidelines and Criteria for Water Quality Management in Ontario.
MOE 1972

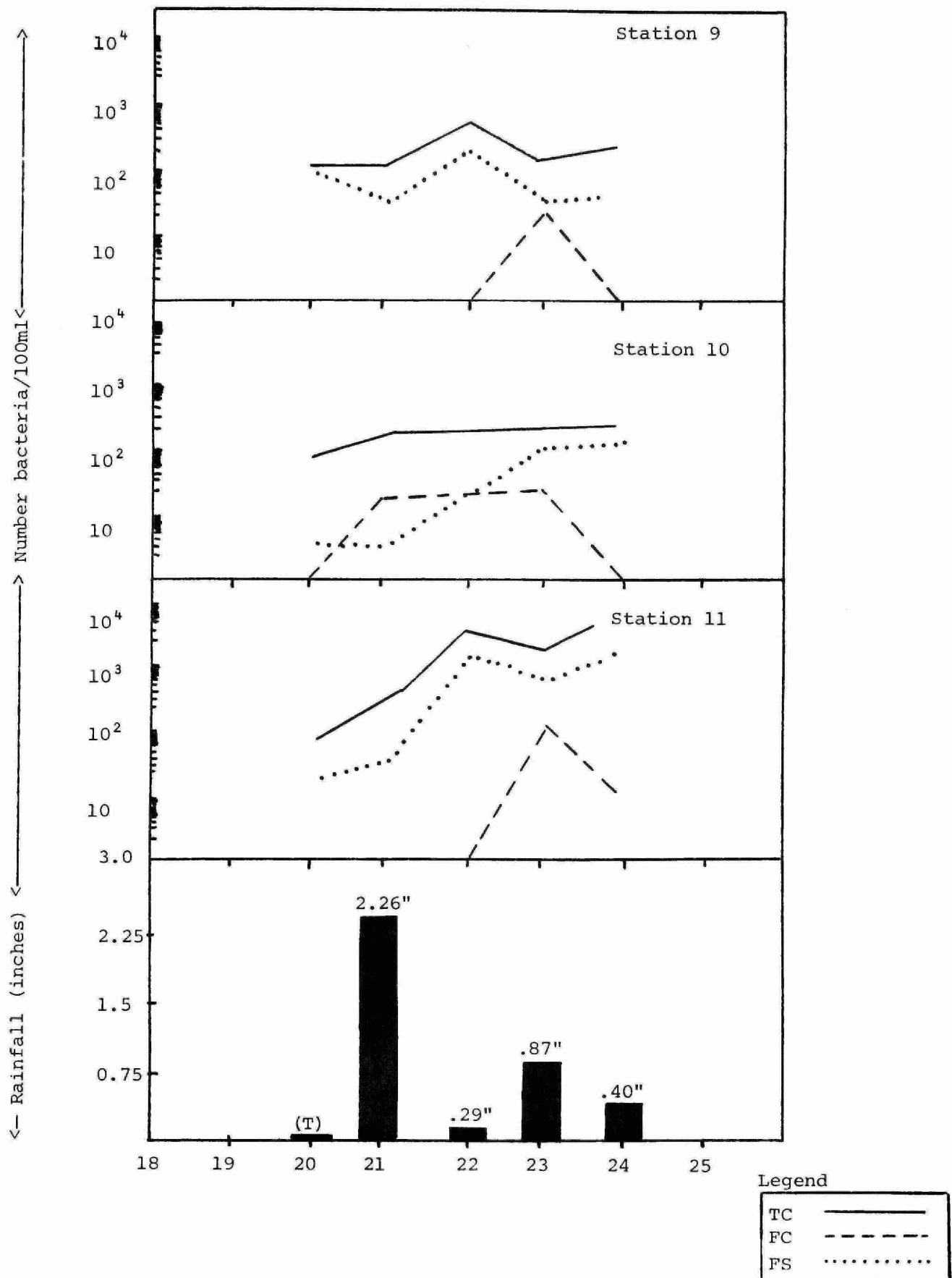


Figure 7: Relationship between rainfall and bacterial levels at Stations 9, 10, and 11 during the June survey.

Chemistry

In June, a zone of rapid temperature decline was apparent between 4 and 9 m at Station 27. Dissolved oxygen concentrations were generally near or above saturation in the surface and bottom waters.

During the August survey, the zone of rapid temperature decline was located approximately 4 m deeper at most stations (Figure 8). Super-saturated oxygen concentrations were still present in the surface waters. However, the dissolved oxygen concentration had decreased in the bottom waters to levels ranging from 30 to 58% saturation.

By the October survey, the zone of rapid temperature decline was located between 11 and 14 m at most mid-lake stations. The bottom waters had almost become void of oxygen rendering these depths unsuitable for fish. For example, the dissolved oxygen in the bottom waters ranged from 2 to 8% saturation at Stations 13 and 27 and from 9 to 35% saturation at Station 43.

Decomposition of aquatic plant growths and other organic matter was likely the cause of this oxygen depletion.

Golden Lake is a soft water lake with an average hardness value of 45 mg/l as CaCO_3 .

The alkalinity and conductivity results correlate well with variations in hardness, and together with chloride and pH data indicate no unusual mineral water quality characteristics.

Average Values:

Alkalinity	31 mg/l as CaCO_3
Conductivity	91 umhos/cm ₃

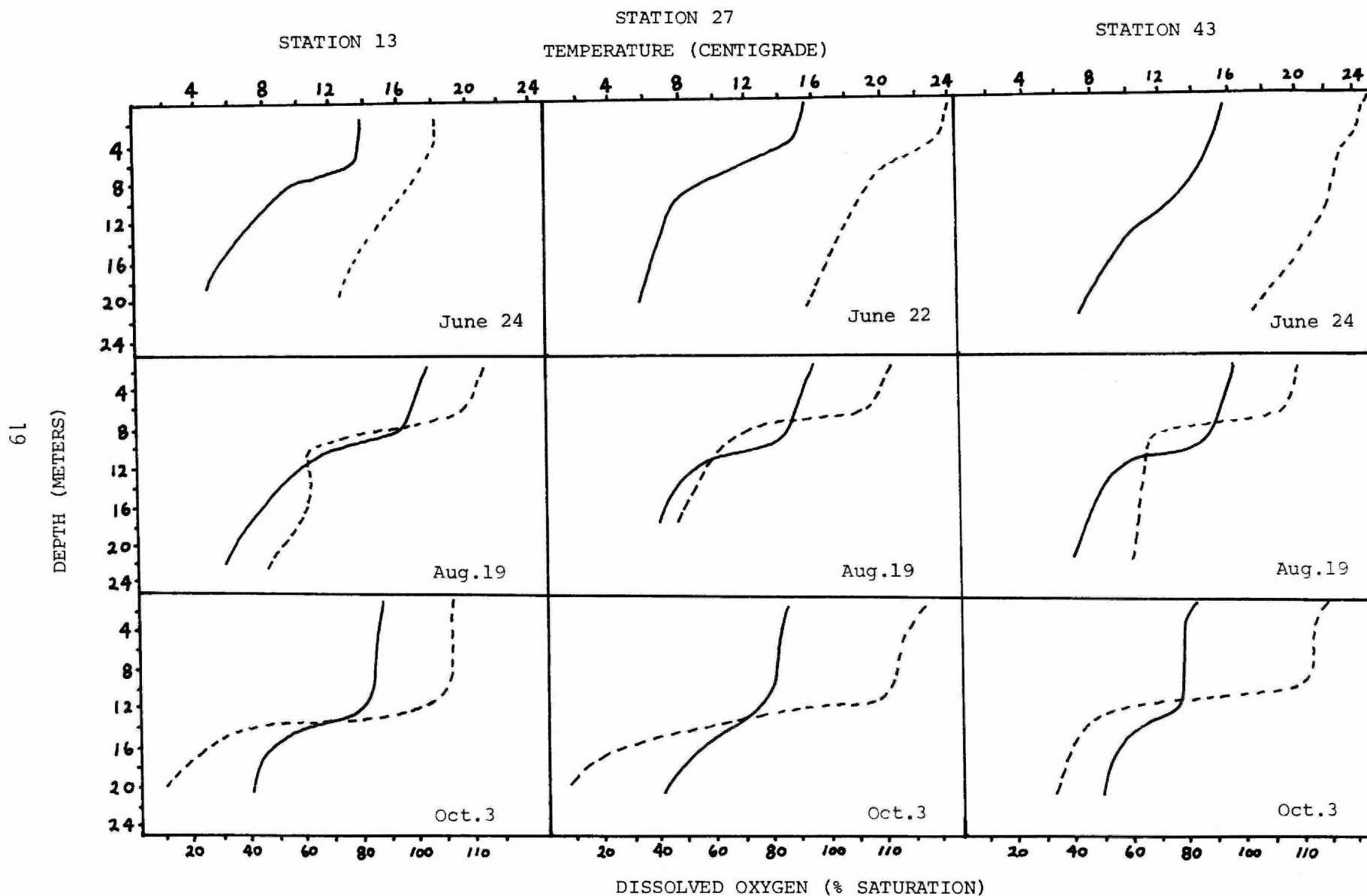


Figure 7: Dissolved oxygen (----) and temperature (—) profiles at Stations 13, 27 and 43 in Golden Lake.

Chloride	2.6 mg/l
pH	6.9 units

The average total kjeldahl and total phosphorus concentrations throughout the surface waters were low with average values of 0.41 and 0.014 mg/l respectively. These values would not be expected to cause nuisance growths of algae. Phosphorus concentrations in the bottom waters were slightly higher. Nutrient concentrations at the mouth of the inflowing Brudenell Creek were greater than the rest of the lake, with mean values of 0.032 mg/l P and 0.67 mg/l N. Lower nutrient concentrations in the Brudenell Creek can be expected following the installation of the Village of Killaloe Station sewage works.

Chlorophyll a and Water Clarity

As indicated by chlorophyll a, all of the deep water sampling stations were characterized by very low quantities of suspended algae in the illuminated zone of the lake. The mean concentration of chlorophyll a over the three surveys was 1.5 ug/l. Water clarity, which is measured by a Secchi disc, is another important parameter used in defining water quality. In Golden Lake, the water clarity was moderate with a Secchi disc reading of 3.2m. This value was somewhat less than expected in view of the low chlorophyll a levels. Particulate or dissolved material other than living algae may have caused a reduction in the clarity of the lake. Larger amounts of suspended algae in the lake are probably limited by the low quantity of nutrients.

CHLOROPHYLL a - SECCHI DISC RELATIONSHIP

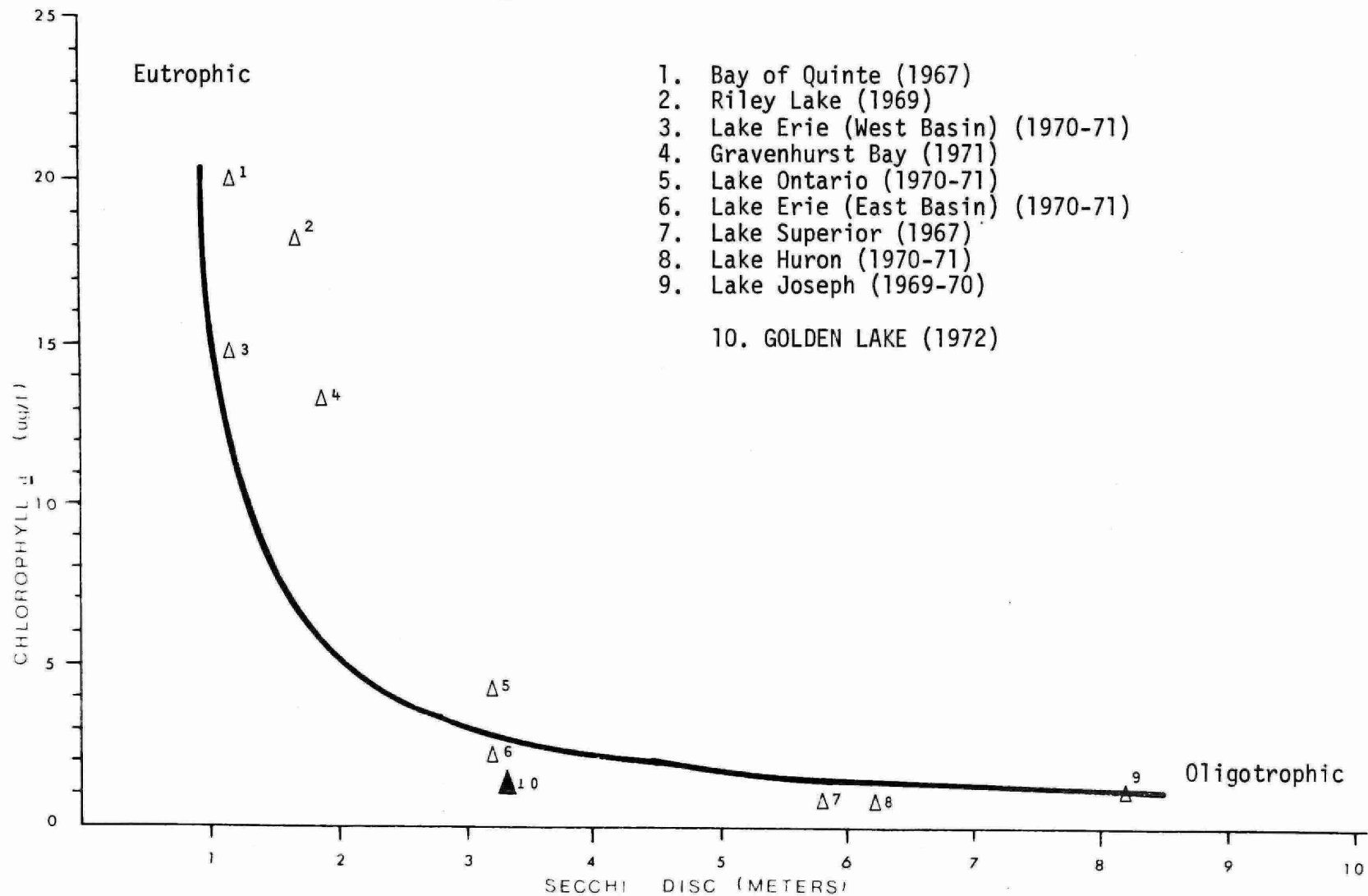


Figure 9: The mean of chlorophyll *a* and Secchi disc measurements in Golden Lake relative to a curve describing the chlorophyll *a* - Secchi disc relationship in many Ontario lakes. Nine other well known lakes are included for comparison with Golden Lake.

Incidence of 'Swimmer's Itch' In Golden Lake

The occurrence of 'swimmer's itch' in the sandy lakes and rivers of the Upper Ottawa Valley is a well-known phenomenon and one which causes some discomfort to bathers in these waters during the warm summer months of July and August. 'Swimmer's itch' is the name given to a mild skin rash which results from contact with the minute larvae of a trematode worm carried by various waterfowl, particularly ducks. These larvae are released from certain aquatic snails which serve as intermediate hosts in the life-cycle of the trematode worm. The rash produced by the larvae is not detrimental to health and seldom persists for more than a few days. Occasionally, severe cases may require treatment in order to alleviate the discomfort caused by the 'itch'.

Over the past few years, the Ministry of the Environment has devoted a great deal of effort towards understanding the problem and towards formulation of suitable control recommendations. These efforts have been partially successful in that the extent of the problem is now well-documented and our knowledge of the biology of 'swimmers itch' has greatly improved, but on the other hand, the information obtained emphasizes the tremendous difficulties involved in providing a safe, reliable and economical method of control.

The clear sandy bottom of Golden Lake is ideal habitat for the host snail Limnaea catascopium which was particularly plentiful on the extensive shelf lying within the 4m (12 feet) line along the western and northwestern shores. This area encompasses about 1760 acres or 23% of the entire lake. One of the problems associated with chemical control (outlined in Appendix

p.A-14) is well illustrated by a study performed in 1971 at Golden Lake where it was estimated that a single 335 acre section of the northern in-shore waters contained 21 million snails of the species known to harbour the trematode larvae causing 'swimmer's itch'. The area in question included a number of important swimming beaches from which cases of dermatitis have been reported. The cost of chemical treatment required to treat this area at the time was calculated at approximately \$13,000 while earlier studies suggested that such treatment would control no more than 30-40% of the snail population. The investigation supports the belief that current methods for chemical control of swimmer's itch are neither practical nor economical for large, exposed areas of water and that the immediate prospects for reducing the incidence of this nuisance are not encouraging. While it is conceivable that research in other countries may ultimately produce some innovative techniques such as biological control of the snail vectors or of the trematodes themselves, no such methods of control are known at the present time. A continued discussion of the problem is provided in the Appendix (p.A-14).

Aquatic Plants in Shoreline Areas

Aquatic plants representing 13 genera from which 16 different species were identified were found in shoreline areas of Golden Lake (Table 1). Some of the plants could only be identified to genus because they lacked the fruiting or flowering structures necessary for complete identification. A relatively high percentage of the total shoreline length (40%) was populated by heavy growths of aquatic plants including large areas of the western shoreline and most shallow bays on the lake (Figure 10) where water depth

is less than 2 meters. While Figure 10 shows the distribution and total density of the plants, the density or dominance of any particular species was not determined. Control of plant growth (see page A-9) in the in-shore areas of the lake may become a necessary lake management tool in future years if recreational pursuits become hindered by troublesome plant growths.

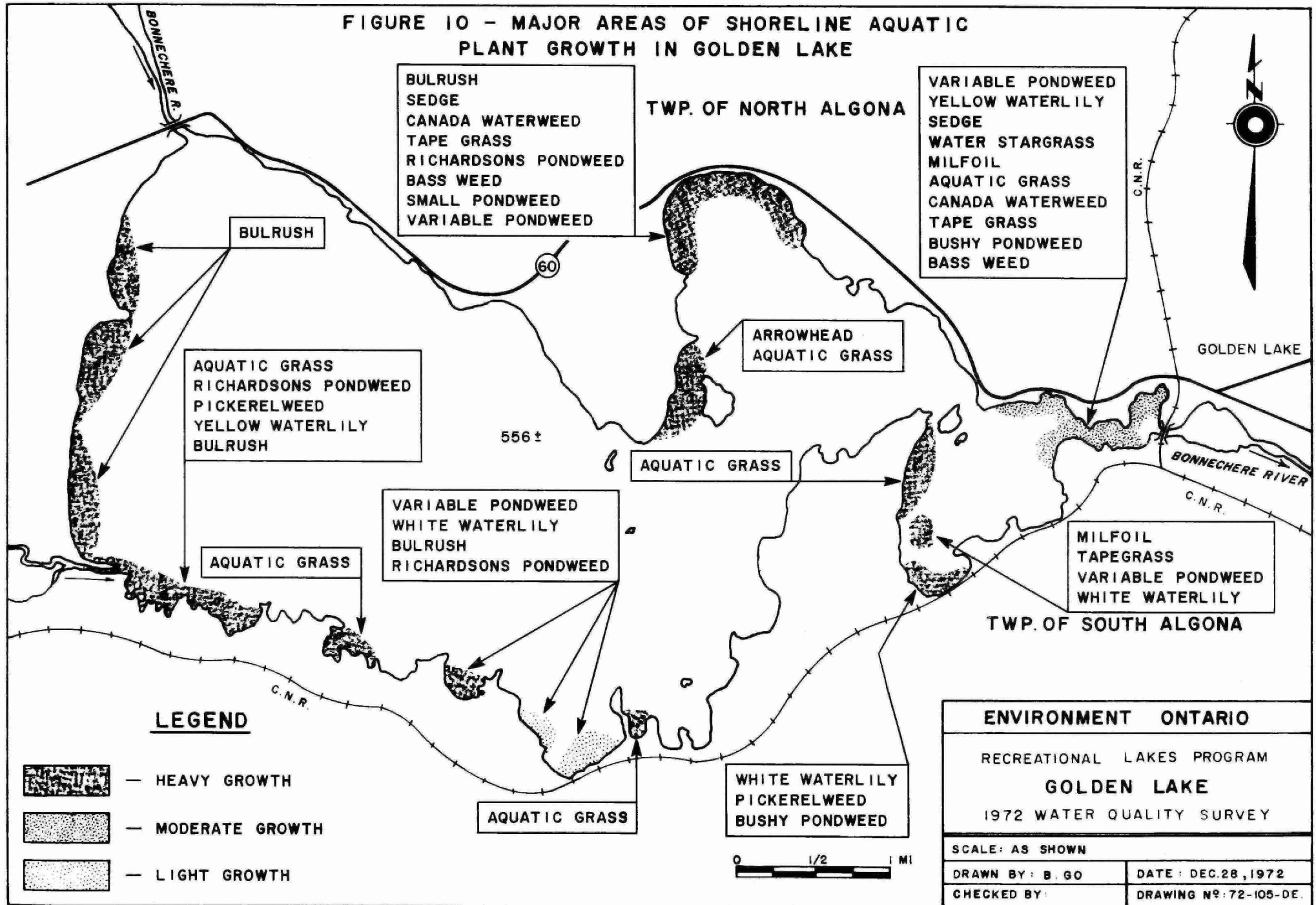
Table 1: Aquatic plants found in shoreline areas of Golden Lake. For convenience, the plants are divided into two categories:

(a) submergent - aquatic plants which live for the most part underwater and (b) emergent - plants which produce floating or aerial leaves.

Scientific Name (Genus, species)	Common Name	Distribution*
(a) Submergent		
<u>Elodea canadensis</u>	Canada waterweed	A
<u>Heteranthera dubia</u>	Water star grass	C
<u>Myriophyllum</u> sp.	Milfoil	A
<u>Najas flexilis</u>	Bushy pondweed	A
<u>Potamogeton amplifolius</u>	Bass weed	C
<u>Potamogeton gramineus</u>	Variable pondweed	C
<u>Potamogeton richardsonii</u>	Richardsons pondweed	V.A.
<u>Potamogeton pusillus</u>	Small pondweed	C
<u>Vallisneria americana</u>	Tape grass	V.A.
(b) Emergent		
<u>Carex</u> sp.	Sedge	C
<u>Nymphaeae</u> sp.	Water lily	V.A.
<u>Nuphar variegatum</u>	Yellow water lily	V.A.
<u>Pontederia cordata</u>	Pickeralweed	A
<u>Scirpus</u> sp.	Bulrush	A
<u>Typha latifolia</u>	Cattail	C
Gramineae (family)	Aquatic grass	A

* V.A. - very abundant
A. - abundant
C. - common

FIGURE 10 - MAJOR AREAS OF SHORELINE AQUATIC
PLANT GROWTH IN GOLDEN LAKE



INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic

matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH per 10 ft depth of water		
Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1. 1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

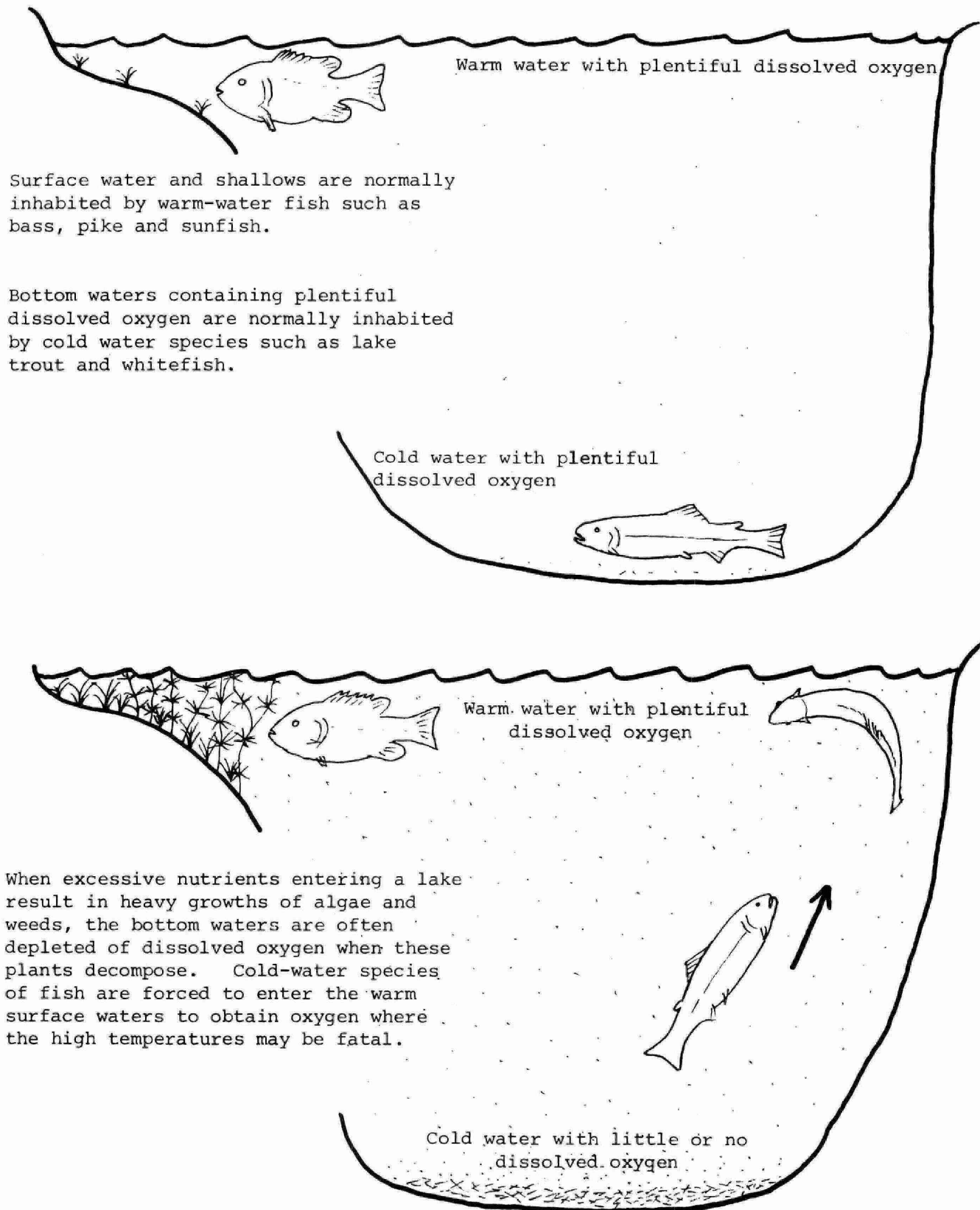


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.

CONTROL OF 'SWIMMER'S ITCH' IN GOLDEN LAKE

The Ministry appreciates that there may be property owners at both Golden Lake and Round Lake who are eager to implement control procedures pending provincial recommendations, and others who may not be entertaining this possibility but are nonetheless interested in the Ministry's findings relative to 'swimmer's itch' and its control. For the information of these people the following summary has been prepared:

1. The occurrence of 'swimmer's itch' in both Golden Lake and Round Lake is the result of natural factors and is not related directly or indirectly to the presence of any polluting substance.
2. The high incidence of 'swimmer's itch' in the lakes and rivers of the Upper Ottawa Valley, in relation to other lakes in southern Ontario, can be explained by the abundance of certain snail species which are important vectors of the trematode larvae and which prefer the sandy lake bottom characteristic of this area.
3. The traditional method of controlling 'swimmer's itch' is by the elimination of snails through the use of copper sulphate or some other chemical with molluscidal properties. Unfortunately the chemicals currently available are not specific to snails and some mortality of non-target organisms must be expected. For this reason the use of chemicals must be restricted to small areas but this practice is not always conducive to effective control of 'swimmer's itch' for the tiny trematode larvae may be released from snails in untreated areas and carried great distances by the action of wind and current. In some cases small sheltered bays may be effectively

treated but the use of chemicals along exposed sections of shoreline is not recommended due to the rapid dissipation of chemical, the high probability of recolonization by the snails and the increased chances of invasion by larvae from untreated areas.

4. Experience has shown that snails inhabit all areas of Golden Lake and Round Lake which are less than 12 feet in depth, Not all snail species common to the lakes are vectors of 'swimmer's itch' and evidence strongly suggests that a different species is the major vector in each of the two lakes. However, it has been noted that in some problem areas the carrier snails constitute a very small percentage of the total snail population. In such situations it is a simple matter for anyone proficient with mask and snorkel to manually collect the carrier snails from the shallow water. This technique has been successfully employed to remove snails from extensive areas of shoreline used for swimming and may be just as effective as large quantities of costly chemical without producing undesirable side-effects. Persons interested in discussing any aspect of 'swimmer's itch' and its control, and in particular those keen to commence a manual-collection project, are invited to contact the Ministry of the Environment, Biology Section personnel at any time.
5. Finally, all bathers in affected waters should be encouraged to follow the golden rules of 'swimmer's itch' prevention (a) on emerging from the water always rub down briskly with a towel and do not allow the water to evaporate on the skin (b) where possible swim in deeper water and avoid in-shore shallow waters.